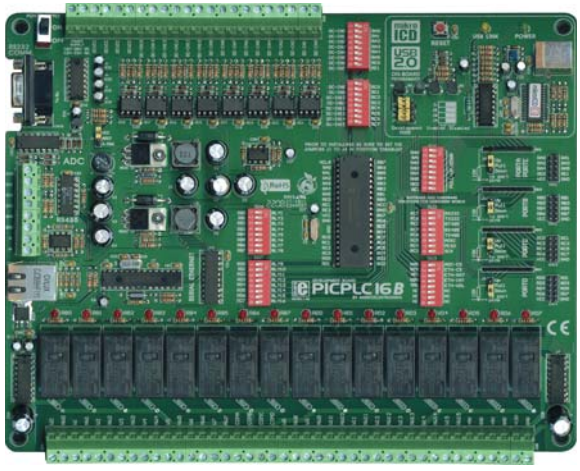
MikroElektronika

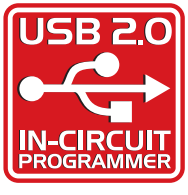
SOFTWARE AND HARDWARE SOLUTIONS FOR EMBEDDED WORLD . . . making it simple

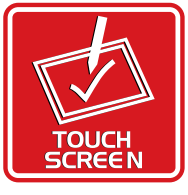
PICPLC16B

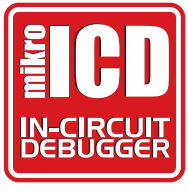


USER'S MANUAL

With useful implemented peripherals, plentiful practical code examples and a broad set of add-on boards (Serial Ethernet, Compact Flash, MMC/SD, etc.), MikroElektronika development boards make fast and reliable tools that can satisfy the needs of experienced engineers and beginners alike.







TO OUR VALUED CUSTOMERS

I want to express my thanks to you for being interested in our products and having confidence in MikroElektronika.
It is our intention to provide you with the best quality products. Furthermore, we will continue to improve our performance to better suit your needs.

Nebojsa Matic
General Manager

DISCLAIMER:
All products are owned by MikroElektronika and protected by copyright law and international copyright treaty. Therefore, you should treat this manual as any other copyright material. The manual and products may not be copied, partially or as a whole without written consent of MikroElektronika. Manual PDF – edition can be printed for private or local use, but not for distribution. Modifying manuals or products is prohibited.

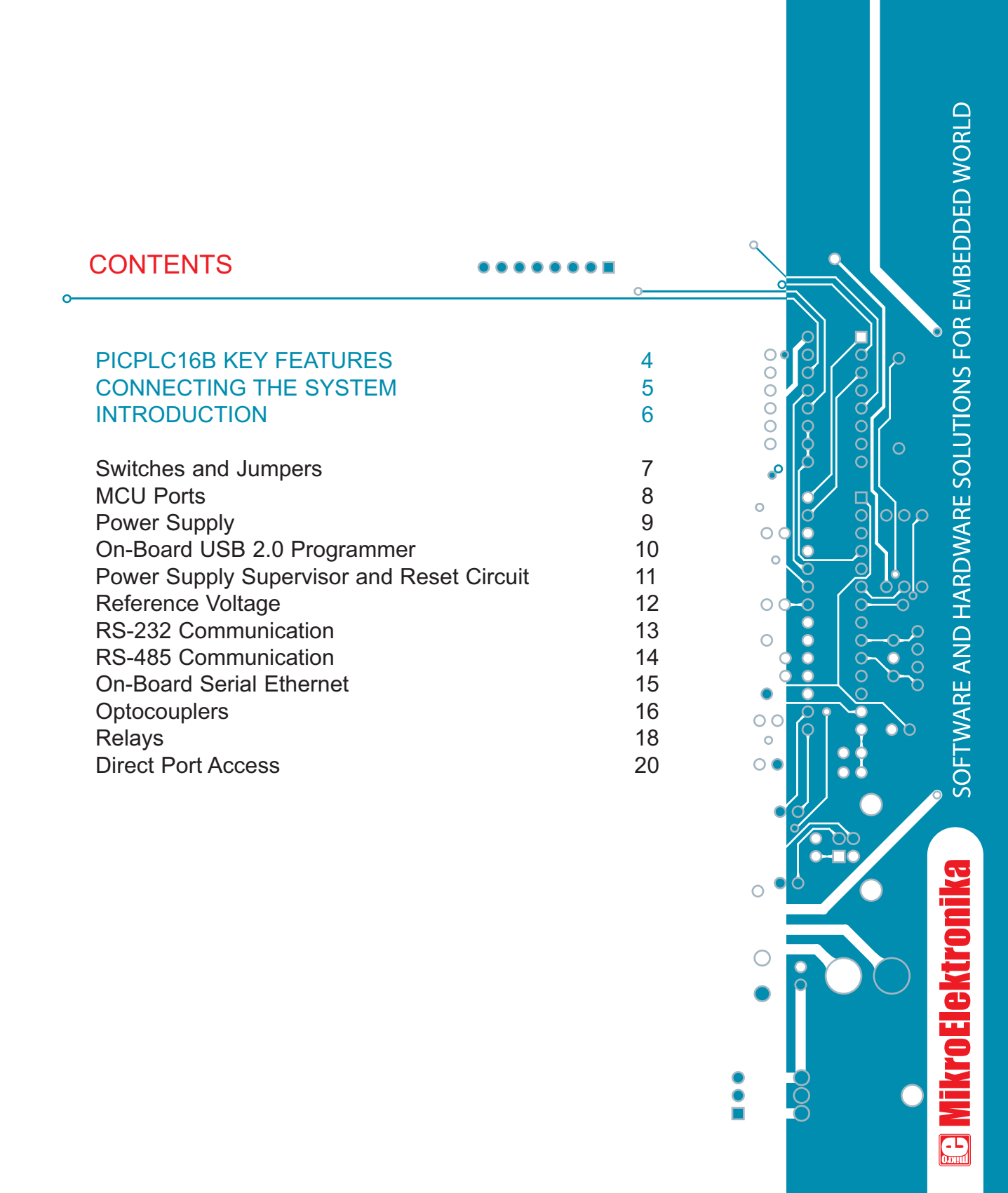
HIGH RISK ACTIVITIES
The products of MikroElektronika are not fault – tolerant nor designed, manufactured or intended for use or resale as on – line control equipment in hazardous environments requiring fail – safe performance, such as in the operation of nuclear facilities, aircraft navigation or communication systems, air traffic control, direct life support machines or weapons systems in which the failure of Software could lead directly to death, personal injury or severe physical or environmental damage ("High Risk Activities"). MikroElektronika and its suppliers specifically disclaim any expressed or implied warranty of fitness for High Risk Activities.

LICENSE AGREEMENT:
By using our products you agree to be bound by all terms of this agreement. Copyright by MikroElektronika 2003 – 2008.

PIC, PICmicro and MPLAB are registered trademarks of Microchip Company. Windows is a registered trademark of Microsoft Corporation. All other trade and/or service marks are the property of the respective owners.

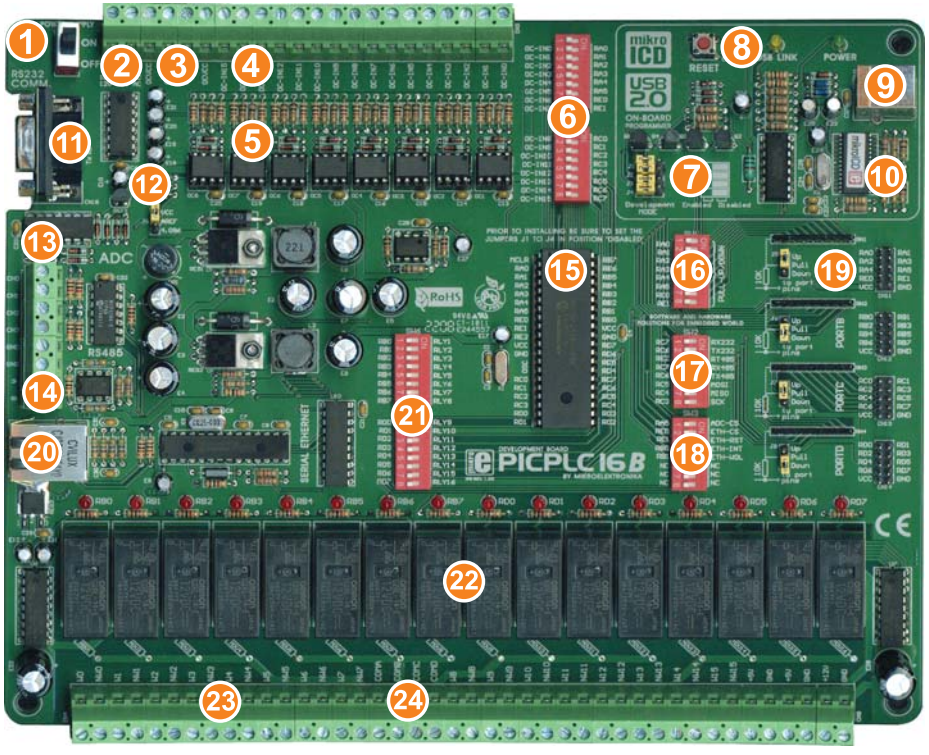
CONTENTS

PICPLC16B KEY FEATURES	4
CONNECTING THE SYSTEM	5
INTRODUCTION	6
Switches and Jumpers	7
MCU Ports	8
Power Supply	9
On-Board USB 2.0 Programmer	10
Power Supply Supervisor and Reset Circuit	11
Reference Voltage	12
RS-232 Communication	13
RS-485 Communication	14
On-Board Serial Ethernet	15
Optocouplers	16
Relays	18
Direct Port Access	20



PICPLC16B KEY FEATURES

1. Power ON/OFF switch;
2. Power supply 16-30V DC or 12-22V AC;
3. Isolated power supply for optocouplers;
4. Optocouplers inputs;
5. Optocouplers;
6. DIP switches SW4 and SW5 used to enable/disable connection between optocouplers and MCU;
7. Development mode jumpers;
8. Reset push button;
9. USB connector;
10. On-board 2.0 USB programmer;
11. RS-232 communication port;
12. Reference voltage;
13. A/D converter input;
14. RS-485 communication port;
15. MCU socket with PIC18F4520 microcontroller;
16. DIP switch SW1 used to enable/disable pull-up/pull-down resistors on PORTA and PORTE pins;
17. DIP switch SW2 used to enable/disable RS232, RS-485 communication and MOSI, MISO and SCK lines;
18. DIP switch SW3 used to enable/disable Ethernet connection;
19. Direct port access connectors;
20. Ethernet communication port;
21. DIP switches SW6 and SW7 enable/disable relays;
22. Relays;
23. Relays outputs; and
24. Change over contact.



CONNECTING THE SYSTEM

Apart from this manual, the PLC (Programmable Logic Controller) system box contains PICPLC16B system, product CD, USB cable, RS232 cable and user's manual for the PICPLC16B. In order to use the PICPLC16B properly, it is necessary to go through the following steps:

Step no.1 Take your development system and product CD out of the box. Insert the product CD into CD drive. Please, do not connect development system to PC yet.

Step no.2 Install *PICFlash2* programmer software to enable a program to be transferred from PC to the microcontroller chip. Installation instructions are contained in the '*PICFlash 2 programmer*' manual.

Step no.3 Install USB drivers on your PC to enable programmer's hardware to operate properly on the PICPLC16B board. For detailed installation instructions refer to the '*Installing USB drivers*' manual.

Step no.4 Connect the PICPLC16B to external power supply and, for programming, to PC using USB cable. Please use one of USB ports on the back of the PC because they are directly connected to the computer motherboard.
The first time you switch the PICPLC16B on, your PC will automatically detect a new hardware. You will be immediately prompted whether Windows should search for new drivers update or not. Select the option '*No, not this time*' and click '*Next*'. Another window appears, click 'Next' and the operating system will automatically find the drivers. Click '*Finish*' to complete this process and run *PICFlash 2* as explained in '*PICFlash 2 programmer*' manual.
Next time you switch the PICPLC16B on, Windows will not ask for new drivers update during driver installation.

After these four steps, your PICPLC16B is successfully installed and ready for use. You can read a program from the chip or write a new one into it. The product CD provides numerous simple program examples that will make your first steps Easy...

INTRODUCTION

PICPLC16B is a programmable logic controller design to control devices in industry and automatics using relays. It has a built-in programmer so that there is no need for additional hardware for the microcontroller programming. Besides, this controller has inputs isolated by optocouplers, 12-bit A/D converter, RS-232 and RS-485 communication modules and Ethernet communication module as well. Four IDC-10 male connectors enable the PICPLC16B to be directly connected to the microcontroller pins, if needed.

Figure 1 illustrates the PICPLC16B development system. As seen, there are identification marks next to each component on a silkscreen, both on the top and bottom. These marks describe connections to the microcontroller, operation modes and provide other useful information so that there is almost no need for additional schematics.

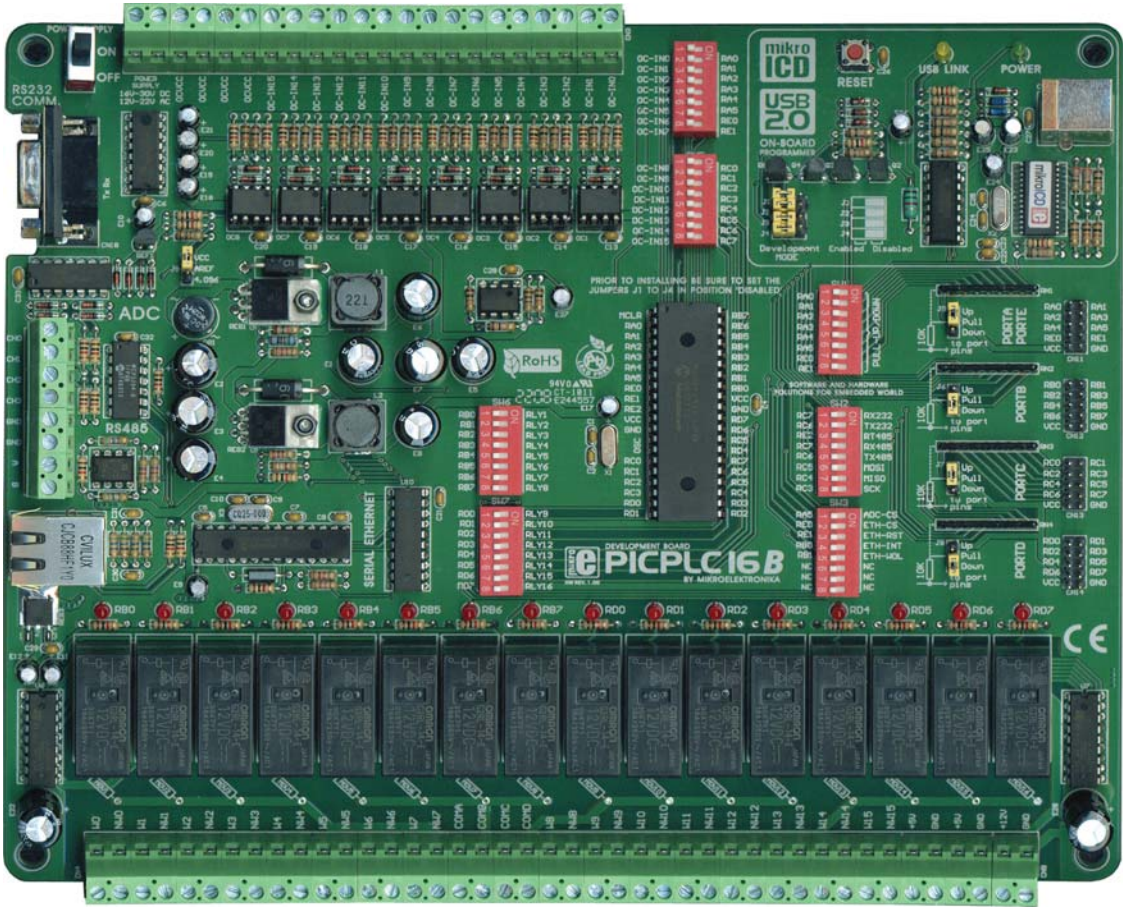


Figure 1 PICPLC16B

SWITCHES

The PICPLC16B development system features a number of peripheral devices. In order to enable them before programming, the appropriate jumpers or switches have to be properly set. Switches are mechanical devices used to establish or break connection between two contacts. The PICPLC16B development system has seven groups of switches.

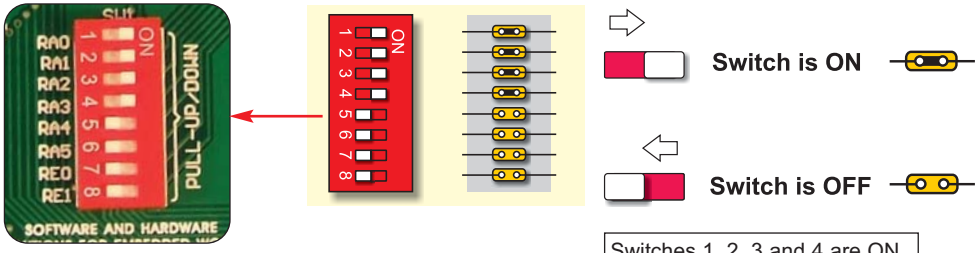


Figure 2 Switch group SW1

DIP switch **SW1** is used to enable external pull-up/pull-down resistors on PORTA and PORTE;
DIP switch **SW2** is used to enable/disable lines between RS-232 module (RX232 and TX232), RS-485 module (RT485, RX485 and TX485) and communication lines (MISO, MOSI and SCK);
DIP switch **SW3** enables Ethernet connection;
DIP switches **SW4** and **SW5** enable/disable optocouplers inputs; and
DIP switches **SW6** and **SW7** enable/disable connection between MCU and relays.

JUMPERS

Similarly, jumpers are used to break or establish connection between two points. Under the plastic cover of a jumper, there is a metal contact which establishes connection when the jumper is placed over two pins.

Jumper is commonly used as a selector between two possible connections via 3-pin connector. As illustrated in Figure 3, the middle connector pin can be connected to the left or right pin, depending on the jumper's position.

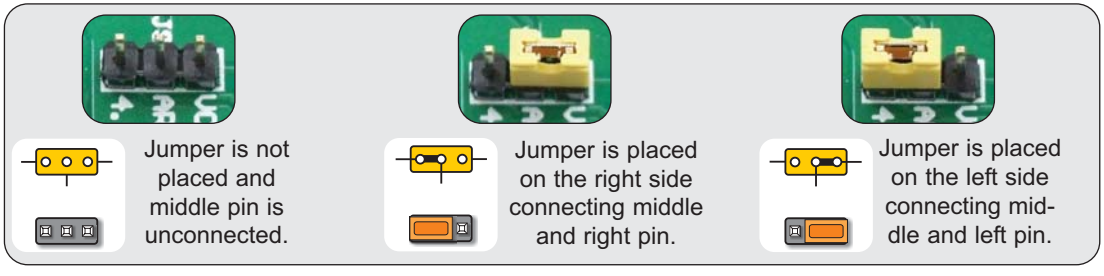
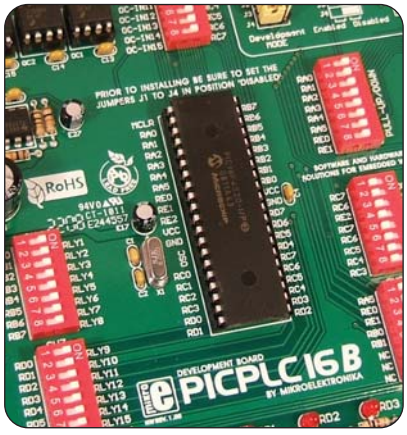

Jumper is not placed and middle pin is unconnected.
Jumper is placed on the right side connecting middle and right pin.
Jumper is placed on the left side connecting middle and left pin.

Figure 3 Jumper as a selector

MCU PORT

The PICPLC16B comes with 40-pin microcontrollers PIC18F4520 in DIP40 package.



The microcontroller pins are routed to various peripherals. All ports are directly connected to Direct Port Access Connectors which are normally used for connecting external peripherals to the board or as points for connecting digital logic probes.

Some pins are connected to other peripherals such as optocouplers, RS-232 communication, RS-485 communication, etc.

Figure 4 PICPLC16B MCU Port

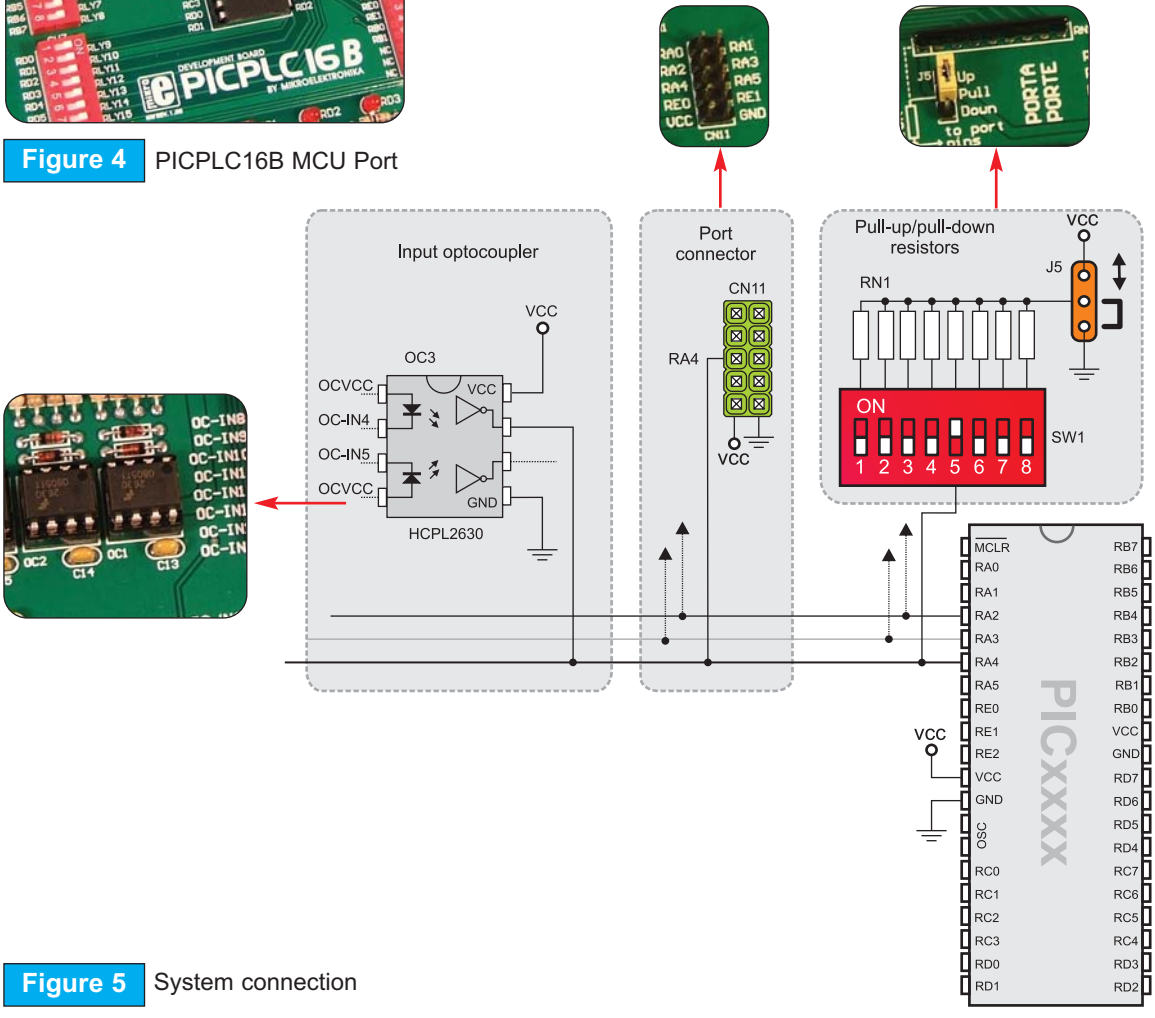


Figure 5 System connection

POWER SUPPLY

The PICPLC16B can use two independet power supply sources. One of them is PICPLC16B board power supply and the other is isolated power supply for optocouplers.

Power supply for PICPLC16B board can be AC or DC. AC power supply voltage ranges between 12 and 22V, whereas DC power supply voltage ranges between 16 and 30V. Isolated power supply for optocouplers is denoted by OCVCC on the board. Figure 6 illustrates power supply connector.

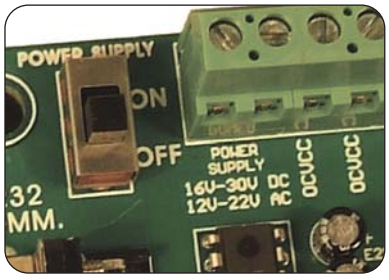


Figure 6 Power supply connector

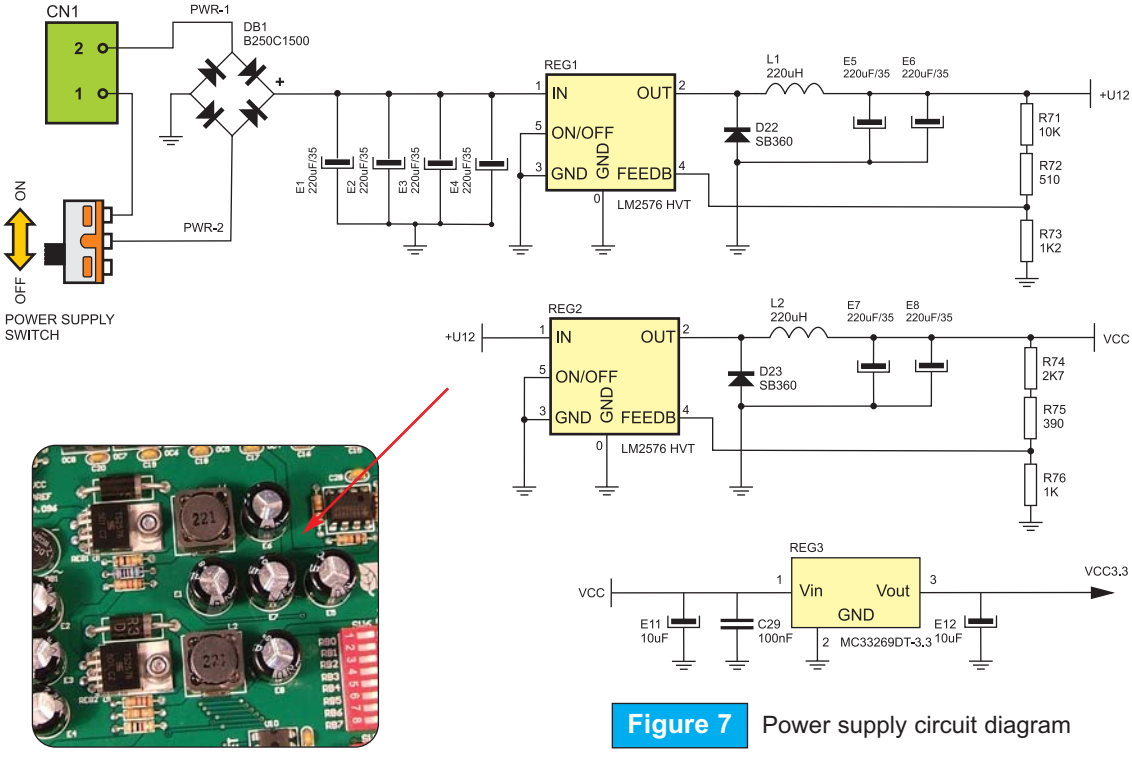
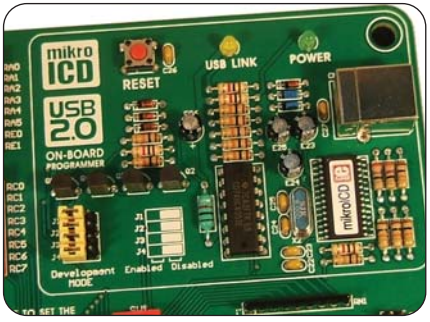


Figure 7 Power supply circuit diagram

ON-BOARD USB 2.0 PROGRAMMER



There is no need to use external equipment during programming as the PICPLC16B development system has its own on-board USB 2.0 programmer.
All you need to do is to connect the system to PC using the USB cable, enable Development MODE by setting jumpers J1, J2, J3 and J4 in the left hand position and turn the power switch on.
Use the *PICflash2* programming software, supplied with the board, to load a program into the microcontroller.

Figure 8 USB 2.0 programmer

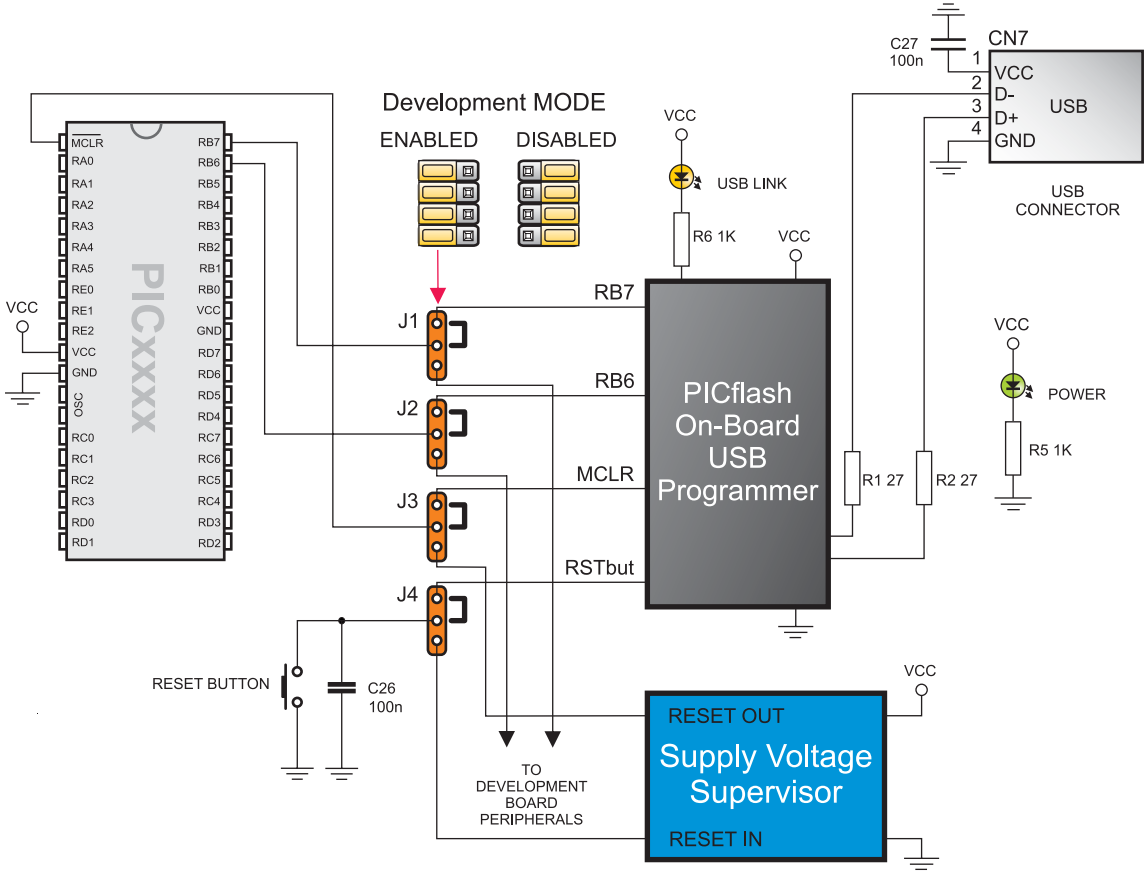


Figure 9 USB 2.0 programmer circuit diagram

POWER SUPPLY SUPERVISOR AND RESET CIRCUIT

In industrial environment it is very important to have a reliable device capable of performing under different conditions. The most important issue for all electronic circuits is a stable power supply. However, in harsh environments there can be some deviations from the power supply nominal values. A power supply supervisor monitors power supply level and restarts the microcontroller if it is too low or too high. It can also be connected to reset button, thus generating reset signal when the button is pressed.

Figure 10 Power supply supervisor

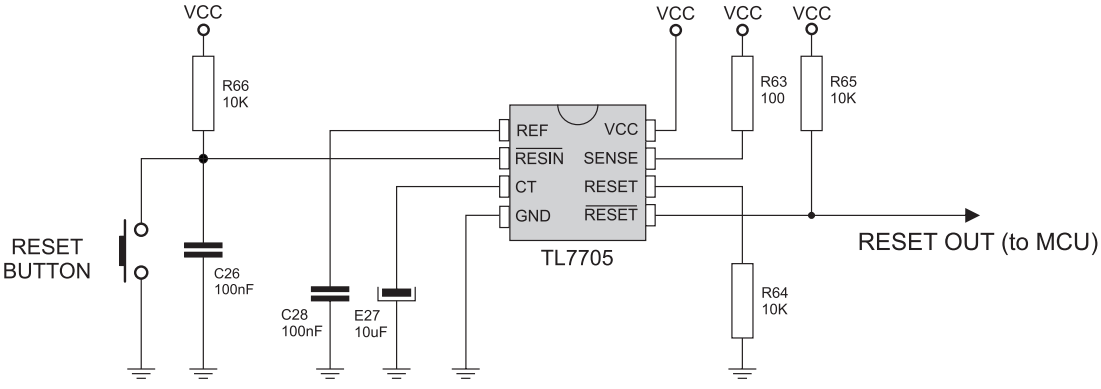


Figure 11 Power supply supervisor circuit diagram

VOLTAGE REFERENCE

Voltage reference is an electronic circuit that produces fixed (constant) voltage, which in our case amounts to 4.096V. It is used in both Analog-to-Digital (ADC) and Digital-to-Analog Converter (DAC) to specify input and output voltage ranges.

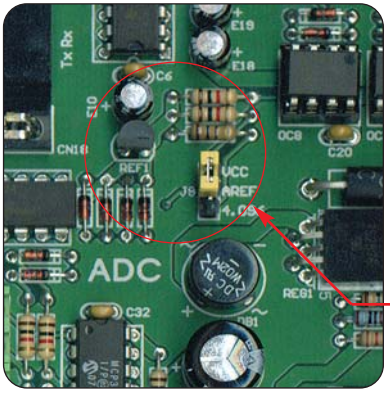


Figure 12 Voltage Reference

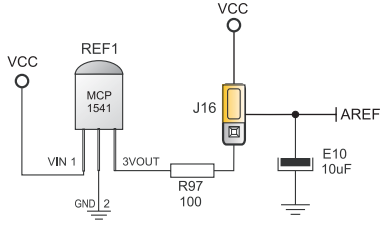


Figure 13 Voltage reference circuit diagram

RS-232 COMMUNICATION

RS-232 communication enables point-to-point data transfer. It is commonly used in data acquisition applications to transfer data between the microcontroller and PC. Since the voltage levels of the microcontroller and PC are not directly compatible with each other, a level converter such as MAX232 must be used.

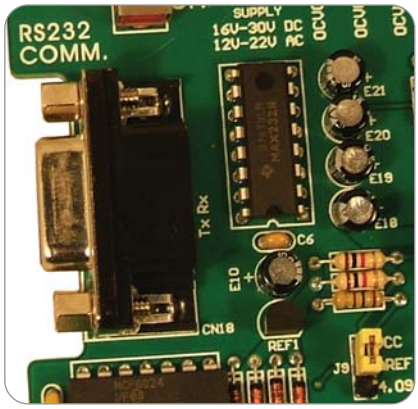


Figure 14 RS232 connector

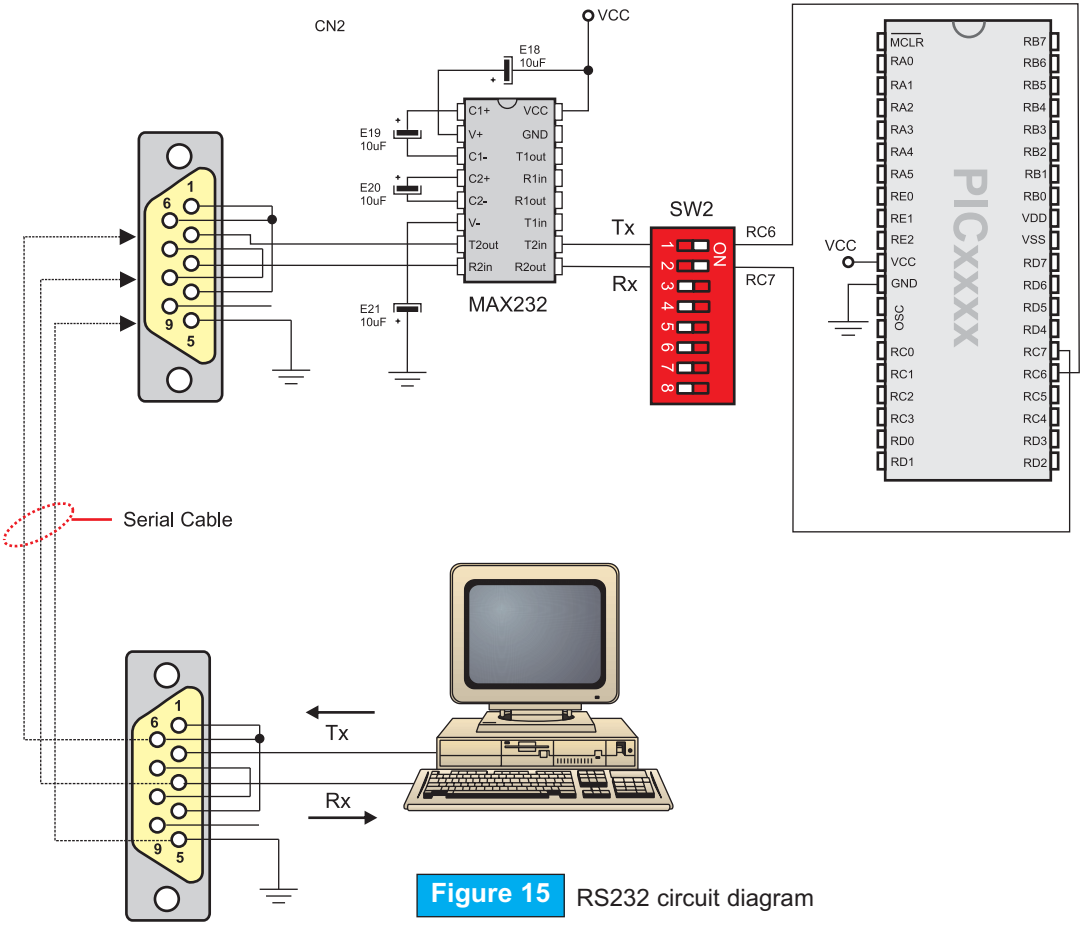
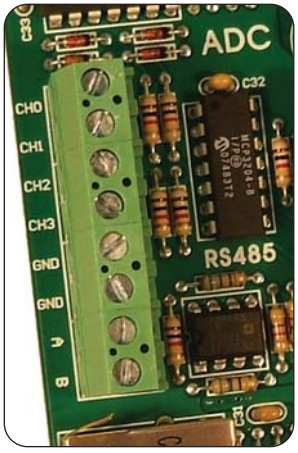


Figure 15 RS232 circuit diagram

RS-485 COMMUNICATION



RS-485 communication enables point-to-point and point-to-multi-point data transfer. It is commonly used to enable data transfer between several microcontrollers. LTC485 interface transceiver is used for transforming signal on microcontrollers Rt, Rx and Tx lines into a differential signal on A and B lines.

The PICPLC16B development board has one RS-485 communication device. In order to provide more flexible system, the microcontroller is connected to LTC485 via three switches (3,4 and 5) of DIP switch SW2.

Figure 16 RS-485 communication

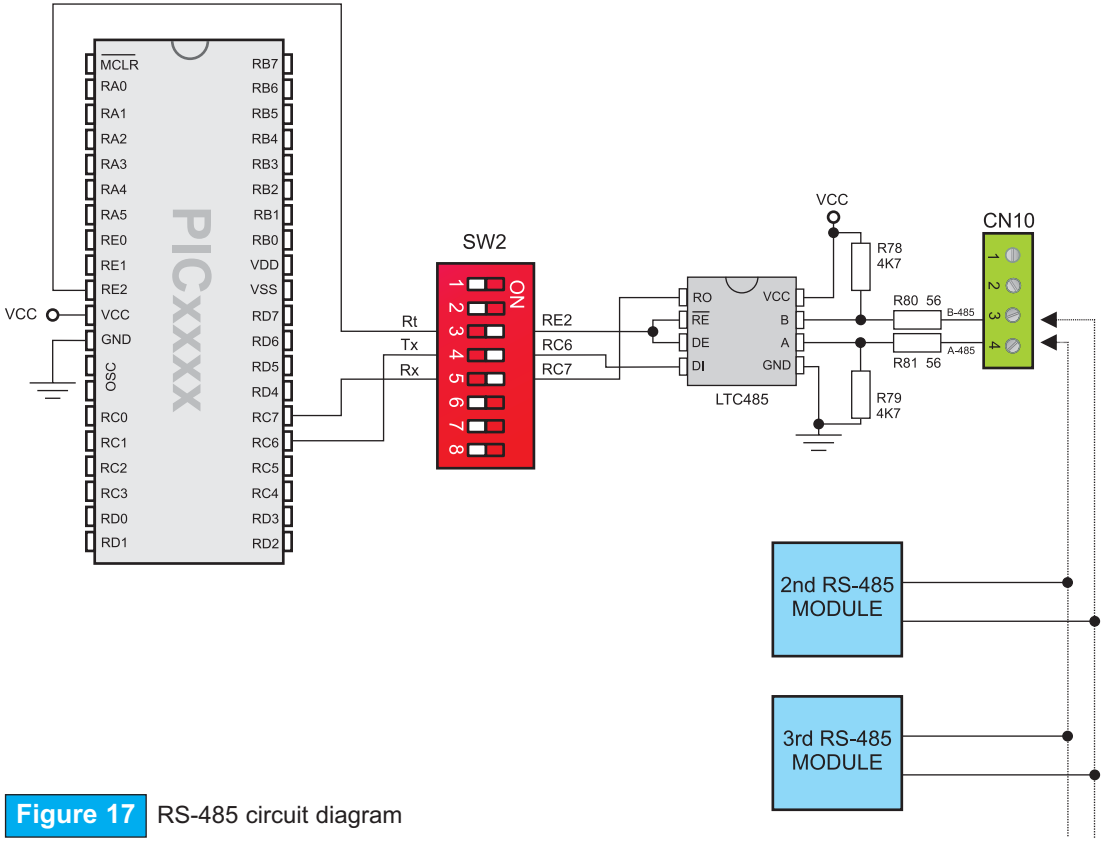


Figure 17 RS-485 circuit diagram

ON-BOARD SERIAL ETHERNET

Ethernet is a most commonly used Local Area Network (LAN) technology today. On the top of physical layer, Ethernet stations mutually communicate by sending data packets to each other. Each station is assigned a single 48-bit MAC address which is used to specify both destination and source of each data packet.

Figure 18 Ethernet connector

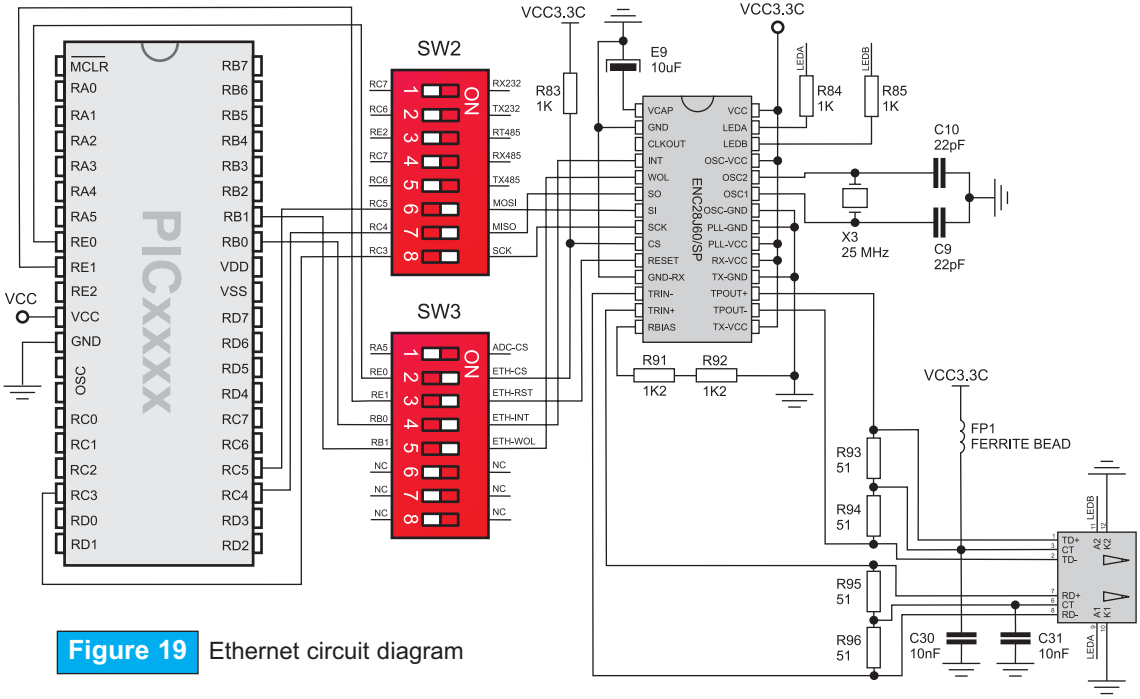


Figure 19 Ethernet circuit diagram

OPTOCOUPLERS

The PICPLC16B has 16 optocouplers inputs. Optocouplers are widely used in industrial applications where inputs must be galvanized, i.e. electrically isolated from the rest of development board. The main idea is to protect the microcontroller from voltage spikes that might occur on input lines.

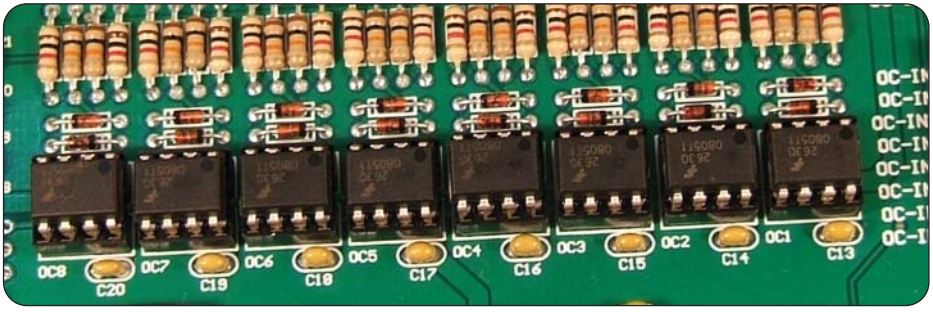


Figure 20 Optocoupler group

In order that input circuit is electrically isolated from the rest of board, it must have its own power supply (12V DC). The optocoupler chip has one LED on each input and one open collector transistor on each output pin. The first 8 optocoupler outputs are connected to the microcontroller PORTA and PORTE, the other 8 optocouplers outputs are connected to the microcontroller PORTC. PORTA(E) and PORTC must be driven high by putting jumpers J5 and J7 in the upper position.

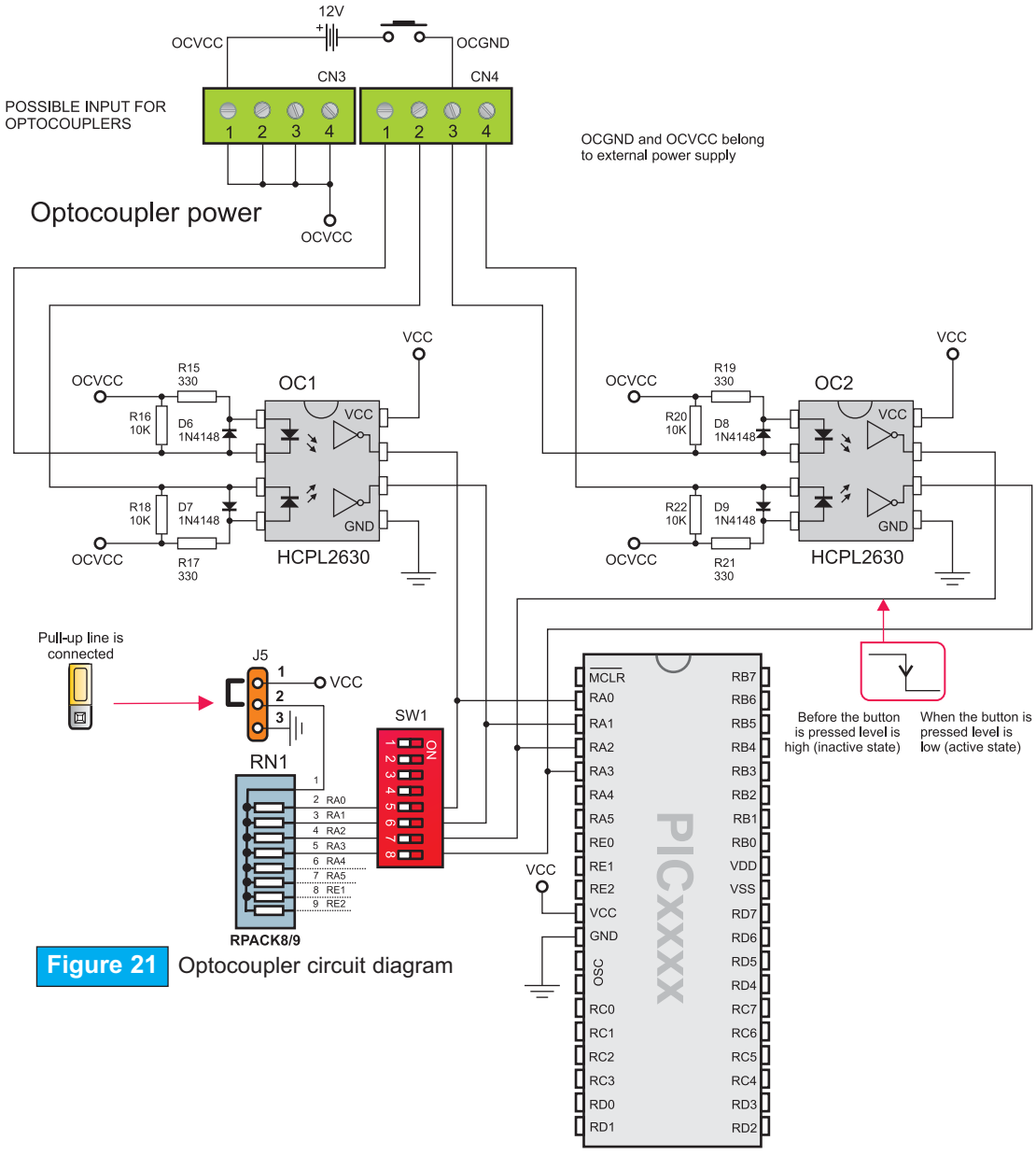


Figure 21 Optocoupler circuit diagram

RELAYS

In order to control devices which use high power for their operation, the PICPLC16B has 16 relays connected to the microcontroller PORTB and PORTD. The relay coil voltage amounts to 12V DC (+U12).

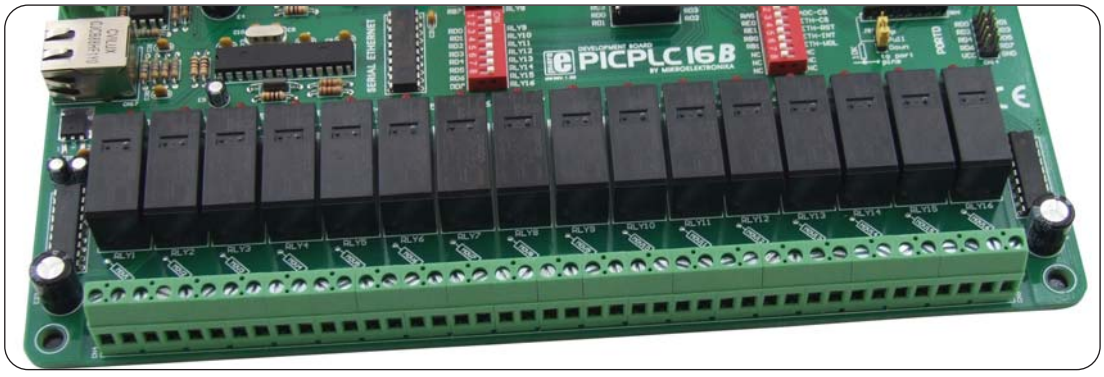


Figure 22 Relays

The microcontroller PORTB and PORTD pins cannot provide enough current necessary to directly run relays and they are connected to the ULN2804 Darlington drivers, therefore. Ports RB and RD must be driven low, i.e. pulled-down, so that relays can be switched on when the microcontroller sets a logic one on any of its outputs. Each relay has one LED connected in parallel with its coil. It is used to indicate whether the appropriate relay is active or not. Reley outputs consist of three contacts: normally-open, normally-closed and change-over, thus enabling any device to be connected to it.

For example, if you connect a light bulb as per Figure 23, it will be turned on by relay activation, i.e. whenever appropriate MCU output is driven high.

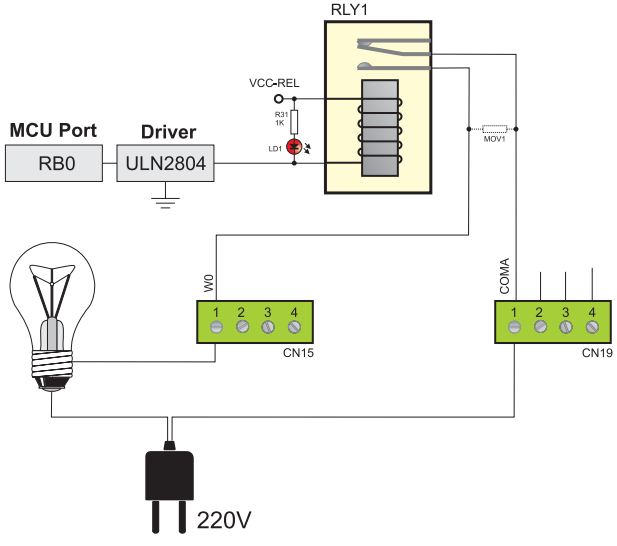


Figure 23 Light bulb connection

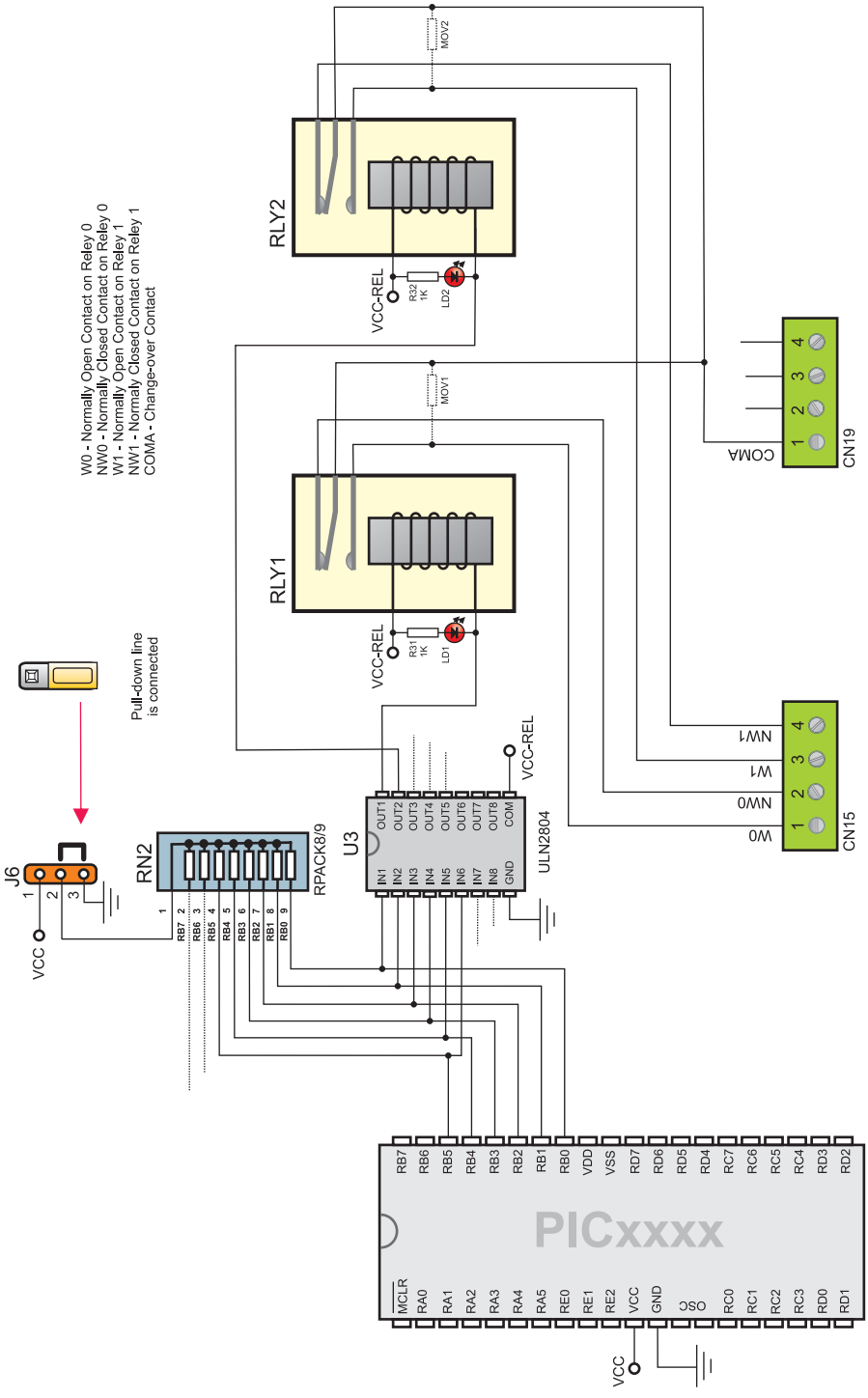


Figure 24 Relays circuit diagram

DIRECT PORT ACCESS CONNECTORS

All microcontroller input/output pins can be accessed via IDC-10 (2x5) connectors placed along the right side of the board. For each microcontroller port, there is one 10-pin connector providing up to eight port pins and two additional pins connected to VCC and GND.

These connectors can be used to connect the system to external devices such as Serial Ethernet, Compact Flash, keyboard etc. If external and on-board peripherals use the same pins, then on-board peripherals must be disconnected from the microcontroller by setting the appropriate jumpers/switches. The connectors can also be used for attaching logic probes or other test equipment.

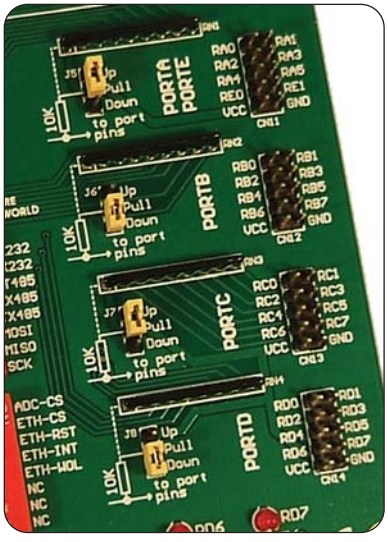


Figure 25 Direct port access connectors

Figure 26 Flat cable connector

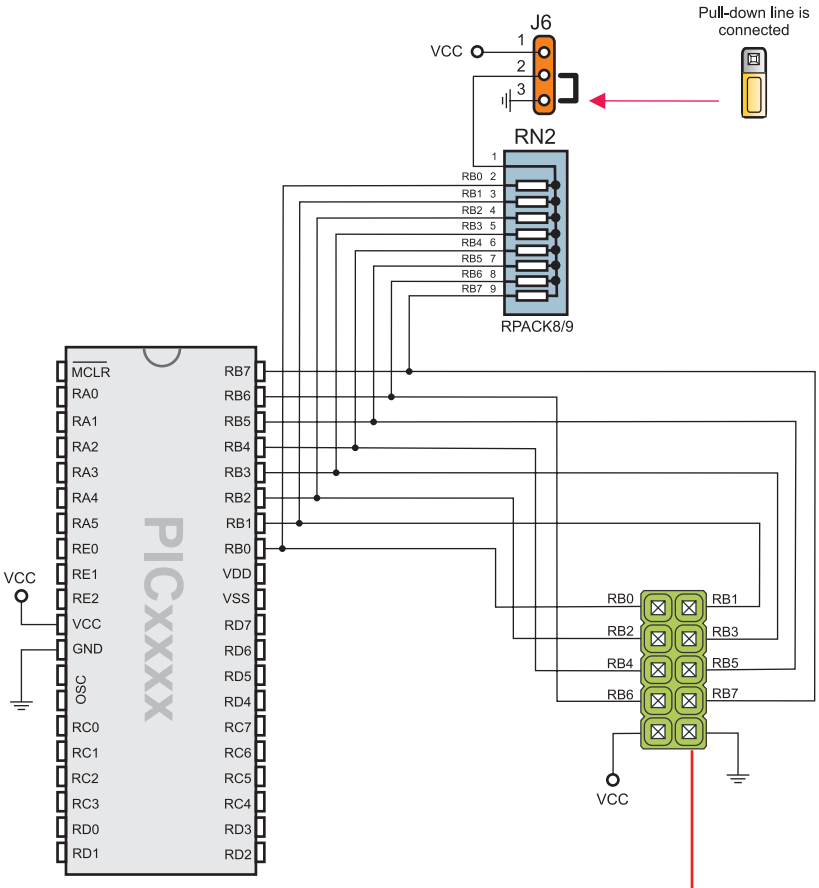


Figure 27 Direct port access circuit diagram

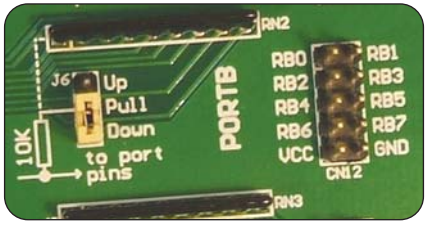
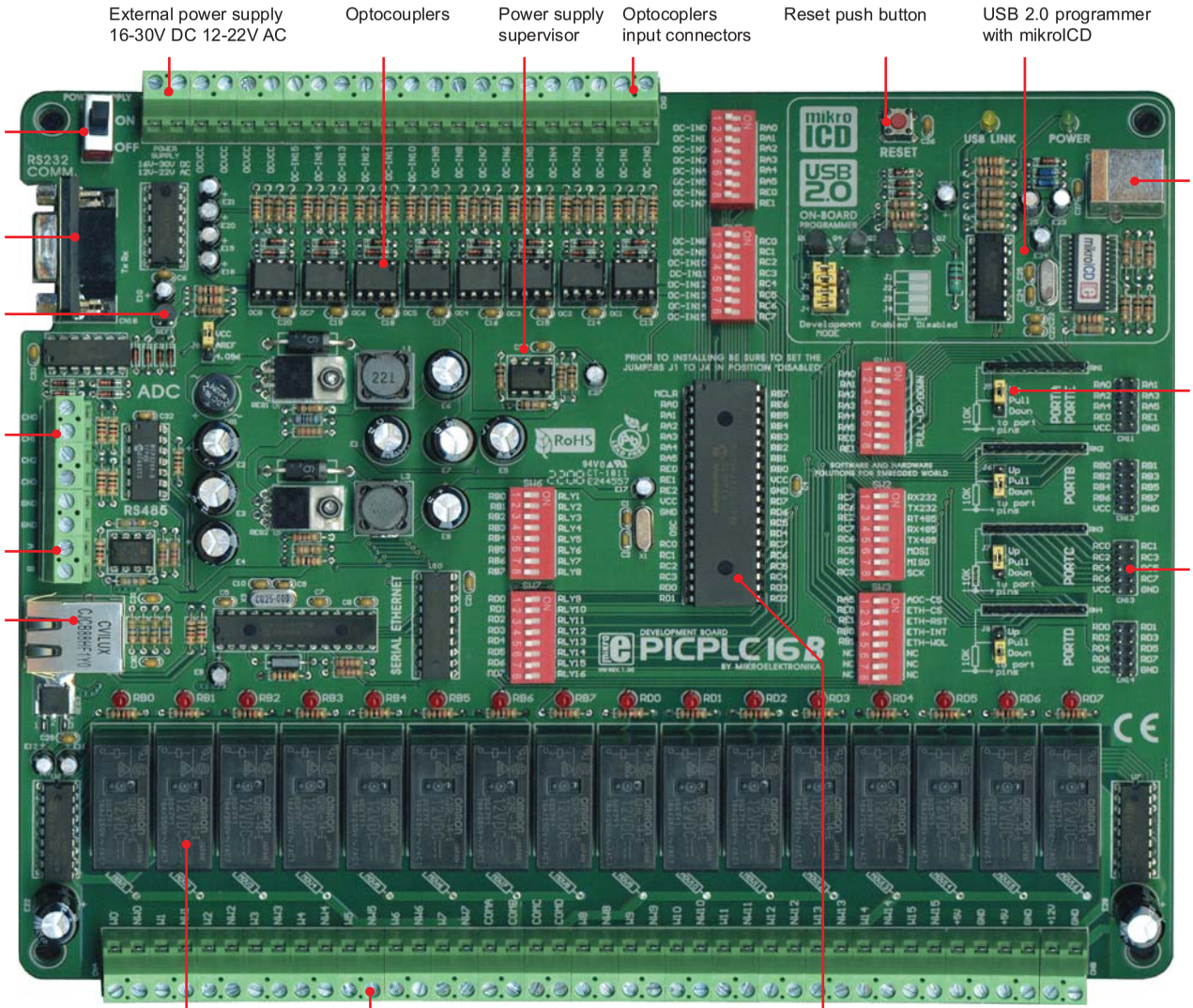


Figure 28 PORTB connector

PICPLC16B



MikroElektronika

SOFTWARE AND HARDWARE SOLUTIONS FOR EMBEDDED WORLD

No part of this manual, including the product and software described in it, may be reproduced, transmitted, transcribed, stored in a retrieval system, or translated into any language in any form or by any means, excepting the documentation kept by the purchaser for backup purposes, without expressed written permission of MikroElektronika company.

Product warranty or service will not be extended if the product is repaired, modified or altered, unless such repair, modification or alteration is authorized in writing by MikroElektronika.

MikroElektronika provides this manual "as is" without warranty of any kind, either expressed or implied, including, but not limiting to implied warranties or conditions of merchantability or fitness for a particular purpose.

In no event shall MikroElektronika, its directors, officers, employees or distributors be liable for any indirect, specific, incidental or consequential damages whatsoever (including damages for loss of business profits and business information, business interruption or any other pecuniary loss) arising from any defect or error in this manual or product, even if MikroElektronika has been advised of the possibility of such damages.

Specification and information contained in this manual are furnished for internal use only, and are subject to change at any time without notice, and should be construed as a commitment by MikroElektronika.

MikroElektronika assumes no responsibility or liability for any errors or inaccuracies that may appear in this manual, including the product and software described in it.

Product and corporate names appearing in this manual may or may not be registered trademarks or copyrights of their respective companies, and are used only for identification or explanation and to the owners' benefit, with no intent to infringe.

MikroElektronika

SOFTWARE AND HARDWARE SOLUTIONS FOR EMBEDDED WORLD ...making it simple

If you have any other question, comment or a business proposal, please contact us:

web: www.mikroe.com
e-mail: office@mikroe.com

If you are experiencing problems with any of our products
or you just want additional information, please let us know.

TECHNICAL SUPPORT: www.mikroe.com/en/support